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Clinical evaluation of cerebral MRI findings in children with cerebral palsy

Cerebral palsy

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Abstract
Aim: In this study, we aimed to investigate the frequency of lesions, which show the hypoxic-ischemic brain damage, their anatomical localization, the timing of the occurrence of the lesions and the causes using the magnetic resonance imaging (MRI) method.
Material and Methods: MRI findings of 150 patient with cerebral palsy (CP) were analyzed. MRI findings, patients' ages, gender, type of birth, birth ages, relationship of parents, additional diseases to CP and clinical type of CP were evaluated. As a control group, 100 healthy children with normal MRI findings of the same age, their gender, types of birth, birth ages, parents relationship and data were compared with the data of children with CP
Results: When etiological factors of CP and the control group were compared, male children were found to be more affected than female. In the age groups, children aged 1-5 were determined to have cerebral palsy more than in the other groups. Related with CP ethiogenesis, prematurity and low birth weight play important roles. On the other hand, negative hospital conditions during and after the birth as well as the curative effect of rapidly developing medical technologies on the babies with high mortality, also have important effects on CP ethiogenesis.
Discussion: Our results show that there are some similarities and differences between the cerebral palsy group and the controls. It was also determined that the MRI method is important in CP diagnosis. Anatomical localisations of the lesions in the brain support the relevant clinical symptoms and thus play an important role in the differential diagnosis.

Keywords
Cerebral Palsy, Children, Brain Damage, MRI

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Introduction

Cerebral palsy (CP) affects various parts of the nervous system that have not yet completed their development, and it is a clinical syndrome characterized by pathologies such as movement and posture disorders, mental retardation (MR), hemiplegia and dysarthria [1].

CP was first defined as spastic rigidity (Little's Disease]) in 1861 by William John Little (1810-1894), an English orthopedist. William John Little, a very good observer, cited abnormal, difficult and prolonged labor, premature birth and neonatal asphyxia as the cause of the disease. [2]. The definition of CP was first used by William Osler. [3].

Damage to the central nervous system (CNS) in patients with CP causes disorders in the neuromuscular, musculoskeletal and sensory systems. These disorders cause insufficiency in the posture and motor functions of the child. Secondary disorders such as various musculoskeletal deformities and the addition of tertiary disorders to the table with the effect of different mechanisms over time, negatively affect the development and functional independence levels of children [4]. Although the damage itself is not progressive, the consequences of inadequacies and disability can be progressive [5].

CP is one of the most common causes of childhood disability. Since the child with CP develops with a lesion in the CNS, symptoms change throughout life and problems that arise can persist throughout their life [6].

The frequency of CP in our country has been determined as 4.4 per 1000 live births, but specified as 8/1000 in some cases. It is stated as 2-2.5/1000 in Europe and Australia and 1.6/1000 in China [7,8].

There is an increase in the frequency of CP, especially in developed countries. This increase has been observed mainly in spastic and ataxic diplegic cases due to the increased chance of survival of immature and premature infants as a result of medical care and technological developments [9].

It is very important to support clinical findings with radiological methods in the diagnosis of CP. It has been stated that especially magnetic resonance imaging [MRI] has been of a great importance in determining the etiology of CP in recent years [9].

In our study, MRIs of patients diagnosed with CP were examined. MRI findings, age, gender, mode of delivery, birth weight, age at birth, presence of consanguineous marriage, diseases accompanying CP, clinical type of CP were evaluated. Etiological factors of healthy children in the same age group who underwent MRI for any reason but did not have any lesions were evaluated and compared with the data of children with CP. In this direction, our aim is to help determine the frequency, anatomical location, timing and causes of the lesions showing hypoxic-ischemic brain injury.

Material and Methods

In our study, we retrospectively analyzed all data of patients diagnosed with CP who applied to the Pediatric Neurology Outpatient Clinic between January 2008 and April 2012.

Our study was conducted after the approval of the clinical research ethics committee of İnönü University with the research protocol numbered 2012/2.

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MRI findings of 150 patients aged 1-16 years were evaluated. In addition, age, gender, birth age, birth weight, mode of delivery, presence of consanguineous marriage, disease accompanying CP, and type of CP were examined.

Age, sex, birth age, birth weight, type of birth, and consanguineous marriage of 100 healthy children who had MRI for any reason at the same age and had no pathology were evaluated and compared with the data of children with CP.

SPSS 15 statistical program was used to evaluate patient and control group data. Data were summarized using mean ± standard deviation values. The Mann-Whitney U, Chi-square and t tests were used for parametric test assumptions, and $p< 0.05$ was considered statistically significant.

Classified as MRI findings, normal, lesion in the corpus callosum, lesion in lateral ventricles, lesion in the cerebrum (lesion in the right hemisphere, left hemisphere, temporal lobe, occipital lobe lesion), lesion in the cerebellum, periventricular leukomalacia (PVL), lesion in the basal ganglia.

The ages of the patients were taken as years from the date of filling the files. Age groups were classified as the first group between the ages of 1-5, the second group between the ages of 6-10, and the third group between the ages of 11-16.

The time of birth was recorded in weeks. Those born at 37 weeks and later were recorded as term, and those born before 37 weeks were recorded as preterm.

Birth weight was recorded in grams, and babies with a birth weight of less than 1500 g were very low birth weight (VLBW), 1500-2500 g babies with a low birth weight (LDA) and 2500 g-4000 g babies were normal birth weight (NDA) were divided into three groups.

Mode of delivery was recorded as normal vaginal delivery (NVYD), home or hospital, and cesarean section (C/S).

It was recorded whether there was consanguineous marriage or not.

Mental retardation (MR), epilepsy, vision problems, speech problems were recorded as accompanying findings with CP.

The patients were classified as quadriplegic, right hemiplegic, left hemiplegic, diplegic, ataxic, hypotonic and mixed type CP.

Results

In our study, MRI findings of 150 patients with CP, 87 males (58%) and 63 females (42%), were evaluated. The male/female ratio was found to be 1,38.

In the control group, 47 healthy girls and 53 healthy boys were evaluated. The male/female ratio was found to be 0.886.

The ages of the patients were between 1-16. There were 77 patients in the first group, whose ages were 1-5 years (%51,3). There were 39 patients in the second group, whose ages were 6-10 years (%26). There were 34 patients in the third group, whose ages were 11-16 years (%22,6). The mean age in the group with CP was 76.8 ±54.96 months.

In the control group, there were 46 healthy children in the first group with an age range of 1-5 years (%46). The second group, whose age range was between 6-10 years, included 30 healthy

children (%30). The third group, whose age range was between 11-16 years, included 24 healthy children (%24). The mean age in the control group was 81.12±45.62 months.

When we evaluated the age of birth in the group with CP, there were 96 patients in the term group who were born at 37 weeks and above (%64), 54 patients (36%) in the preterm group who were born before 37 weeks.

In the control group, there were 88 healthy children in the term group who were born at 37 weeks and above (%88). There were 12 healthy children (12%) in the preterm group who were born before 37 weeks.

There were 42 patients in the very low birth weight (VLBW) group with a birth weight of 1500 g or less (%28). There were 46 patients in the low birth weight (LDA) group birth weight between 1500 g and 2500 g (%30,7). There were 62 patients (41.3%) in the normal birth weight (NBW) group, whose birth weight was between 2500 g and 4000 g.

In the control group, there were 46 healthy children in the low birth weight (LBA) group (%46). There were 54 healthy children (54%) in the normal birth weight (NDA) group (p<0,05).

Sixty-six patients (44%) were born with C/S, 44 patients (29.3%) were born at home with NVYD and 40 patients (26.7) were born in hospital with NVYD.

In the control group, 20 (20%) children were born with C/S; 16 (16%) children were born with NVYD at home, 64 (64%) children were born with NVYD in the hospital.

There was a consanguineous marriage between the parents of 88 patients (58.7%), and in 62 patients (41.3%) there were no consanguineous marriages.

In the control group, there was a consanguineous marriage between the parents of 79 patients (79%), there were no consanguineous marriages in 21 patients (21%) (p<0,05).

Epilepsy was present in 72 (48%) patients, speech problems in 19 (12.66%), visual problems in 10 (6.66%) and MR in 26 (17.3%) patients with CP. There was no accompanying different clinical table in 23 (15.3%) patients with CP.

The clinical CP type of the patients was mostly quadriplegic type CP. There were 82 patients (54.6%) in this group. Twenty-four patients (16%) had hypotonic CP, 8 patients (5.3%) had ataxic CP, 8 patients had mixed CP (5.3%), 13 patients had diplegic

Table 1. Anatomical localization of the lesion in CP cases

Anatomical Localization	Number	%
Corpus Callosum	57	38
PVL	33	22
Lateral Ventricles	16	10,6
Basal Ganglia	10	6,6
Cerebellum	6	4
Cerebrum	18	12

Table 2. Anatomical localization of the lesion in term ve preterm CP cases.

Anatomical Localization	Term	Preterm
Corpus Callosum *	26 (27,33%)	31 (57,40%)
PVL*	18 (18,75%)	15 (26,31%)
Lateral Ventricles *	8 (8,33%)	8 (14,81%)
Basal Ganglia *	8 (8,33%)	2 (3,70%)
Cerebellum	5 (5,208%)	1 (1,85%)
Cerebrum	12 (12,5%)	6 (11,11%)
Right Hemisphere	4 (4,16%)	2 (3,70%)
Left Hemisphere	5 (5,208%)	4 (7,40%)
Occipital Lobe	2 (2,08%)	0
Frontal Lobe	1 (1,04%)	0
Normal	7 (7,29%)	3 (5,55%)

*p<0,05

Table 3. Distribution of anatomical localization of lesions by age groups

Localization	1st group 1-5 age	2nd group 6-10 age	3rd group 11-16 age
Corpus Callosum	38 (25,3%)	6 (4%)	13 (8,6%)*
PVL	24 (16%)	7 (4,6%)	2 (1,33%)*
Lateral Ventricles	5 (3,3%)	8 (5,3%)	3 (2%)
Basal Ganglia	3 (2%)	3 (2%)	4 (2,6%)*
Cerebellum	0	2 (1,3%)	4 (2,6%)
Cerebrum	7 (4,6%)	11 (7,2%)	6 (3,9%)
Right Hemisphere	0	4 (2,6%)	2 (1,3%)
Left Hemisphere	0	6 (4%)	3 (2%)
Occipital Lobe	0	1 (0,6%)	1 (0,6%)
Frontal Lobe	1 (0,6%)	0	0
Normal	6 (4%)	2 (1,3%)	2 (1,3%)

*p<0,05

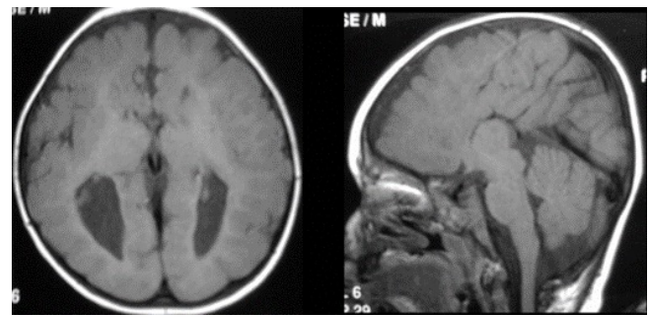

Figure 1. Corpus callosum agenesis

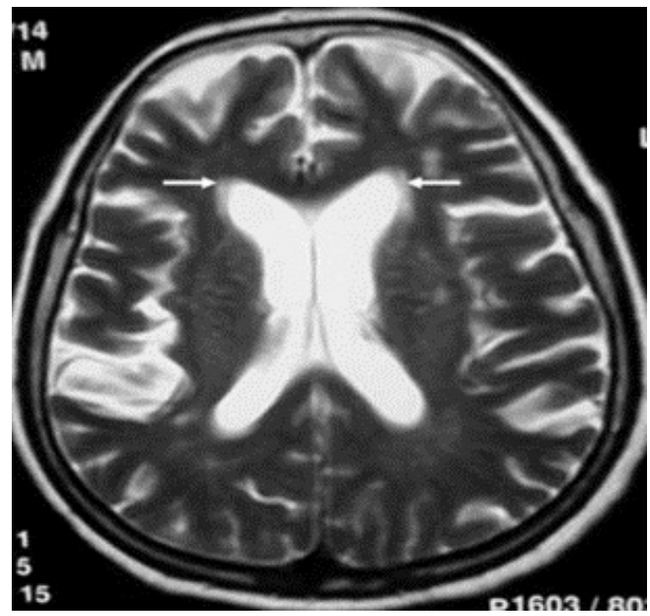

Figure 2. Lateral ventricular dilatation

type CP (8,6%), there were 6 patients with left hemiplegic type CP (4%), and 9 patients with right hemiplegic type CP (6%).

The Anatomical localization of the lesion in CP cases is given in Table 1.

MRI findings of patients diagnosed with CP were evaluated separately in term and preterm cases. , Frequency and localization of the findings are summarized in Table 1.

Anatomical localization of the lesion in term ve preterm CP cases is given in Table 2.

The distribution of MRI findings of patients with CP by age group is given in Table 3.

Discussion

CP is a non-progressive condition that occurs due to CNS damage or anomaly in the prenatal, natal and postnatal periods, but it can lead to various motor dysfunctions over time [8].

In children, the lesion in the CNS and its clinical reflection may change over time. Especially after birth or in the first months of life, motor, movement and posture anomalies may change over time. In addition, the underlying cause of the clinical finding may not be a lesion in the central nervous system, it can also be an indicator of metabolic disease. In these cases, the diagnosis of CP would be misleading or CP becomes more difficult to diagnose. Therefore, we did not include patients younger than 1- year- old in our study [9].

Prematurity has become an important cause of CP with the development of medical technology and the increased chance of survival of infants at a very young birth age [10]. Pellegrino draws attention to the decrease in mortality in preterm infants and the increase in the rate of CP in preterm infants with the widespread use of intensive care units [11].

In our study, unlike previous studies, we evaluated the birth ages of both children with CP and randomly selected healthy children and compared these data. There was no statistically significant difference between the birth ages of the CP group and the control group, but the number of term babies was numerically higher in the group with CP. This rate was in parallel with other studies conducted in our country. The rate of term babies was found to be 76% in one study and 73.6% in another study [12,13]. These data also draw attention to the fact that the poor care conditions of the baby after birth play a major role in the etiology of CP.

According to studies conducted in our country, it has been determined that between 77.8% and 95.1% of children with CP are born with NVYD [3]. In our study, 44% of the patients were diagnosed with C/S; 29.3% of them were born with NVYD at home and 26.6% of them were born in hospital with NVYD; 55.9% of total CP cases were born with NVYD. In the control group, 21% of the cases had C/S; 64% were born with NVYD in the hospital, and 16% were born with NVYD at home.

In terms of these data, when compared with both the control group and with previous studies, no significant value was found for the mode of delivery among the causes of CP. However, the high rate of birth with C/S in the CP group suggests that there should be any problem in the prenatal mother and baby health and that birth with C/S should be compulsory. One of the reasons for this is that the developing medical technology keeps babies who are difficult to live. Therefore, the problems seen in babies born prematurely with C/S are increasing. The reason for the difference in the literature data is thought to be due to the fact that the studies were conducted in different geographical regions and that each region has different sociocultural and socioeconomic levels.

Epilepsy is one of the most common neurological problems in children with cerebral palsy. According to studies, it is thought to be more common in quadriplegic type CP and CP caused by postnatal reasons [14-16]. In previous studies, the rate of cases with CP with epilepsy ranged from 18% to 60% [17]. In our study, epilepsy was accompanying 48% of the cases with CP. As demonstrated in previous studies, most of our cases with CP in our study were quadriplegic type CP, and the most common accompanying neurological problem was epilepsy.

In our study, unlike other studies, we examined CP in terms of extremity involvement and motor movement limitation in 7 groups: quadriplegic type CP, hypotonic type CP, ataxic type CP, mixed type CP, diplegic type CP, right hemiplegic type CP, and left hemiplegic type CP. In previous studies, CP was grouped as spastic, dyskinetic, ataxic, hypotonic and mixed type and among these, the most common type of CP was reported as the spastic type. In the studies conducted, spastic type CP cases were found at a rate of 77% in the USA, 79% in Sweden, 94% in Northern Ireland, 82% in Norway and 86% in Saudi Arabia [18,19].

Our study was similar to some of the other studies in our country in terms of quadriplegic type SP ratio. However, this rate is quite high compared to studies conducted in developed countries. This may be due to poor maternal care in the perinatal period and exposure of risky, preterm and preterm infants to unfavorable hospital conditions. Even patients with a milder clinical type of CP may become quadriplegic due to all these adverse conditions.

In a study conducted in Germany, PVL was reported as the most common pathological finding with a rate of 56% [20]. In our study, this rate was determined as 22%.

Damages that occur during the maturation and development of the brain cause different pathologies in different parts of the brain. For example, damage in the first 20 weeks of the gestational period usually causes lesions in the cerebellum, damage between 24-34 weeks of gestation causes lesions in the periventricular area and problems occurring after 34 weeks of gestation usually cause lesions in the gray matter [19].

Accordingly, when we separately evaluate the MRI findings in term and preterm infants in the CP group, the most common corpus callosum lesion and PVL were detected in MRI findings.

In a previous study, the most common MRI findings in term babies with CP were found to be cortex-subcortical tissue damage with 44.8%, and PVL with a rate of 16.5%. [20]. In another study, it was emphasized that 43.3% cortex subcortical tissue damage, 16.6% cortical migration anomalies, 10% PVL were the most common MRI findings [14].

Conclusion

In our study, we found that the etiological factors and MRI findings showed some differences from the findings of studies conducted both in Turkey and abroad.

In the etiology of cerebral palsy, it was determined that the negative hospital conditions during and after birth, as well as premature and low birth weight births and the survival of

babies who did not have a chance to survive with the developing medical technology were also important. In this case, it was concluded that the frequency or severity of CP could be reduced by raising the standards of delivery rooms and infant intensive care units, by making good pregnancy follow-up and raising the awareness of pregnant women. MRI method has an important place in the diagnosis of CP; the anatomical localization of the lesion formed in the brain overlaps with the clinic and plays a role in the differential diagnosis of the clinical type; It has been understood that it is a mandatory method to be applied in the suspicion of CP.

It is thought that more studies should be done on early detection of the disease, understanding the age limit and the exact causes.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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